

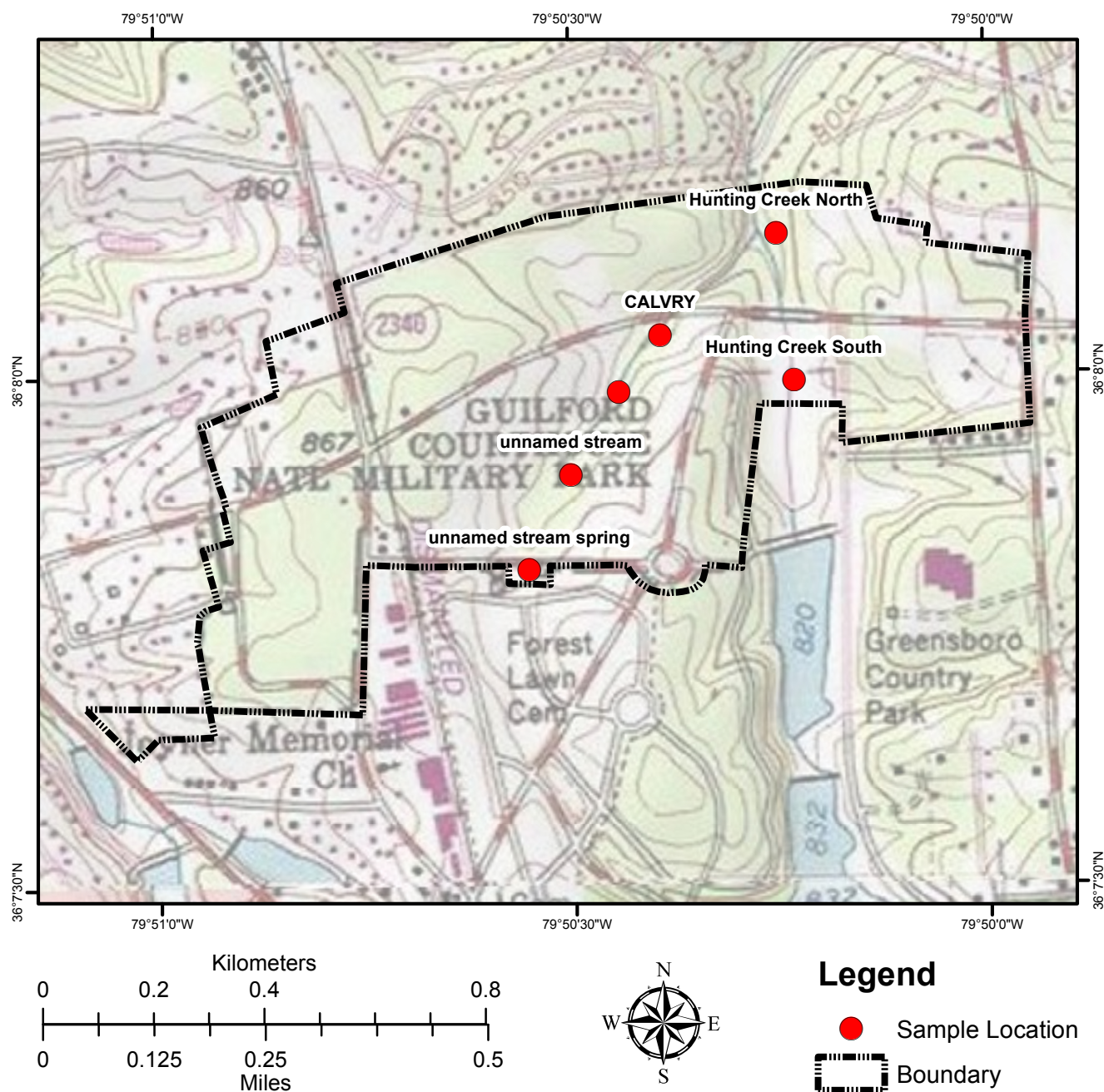
Appendix 1. Locations and Events

Each location at which samples were collected is listed below by the SiteCode given in the database. Each location is unique, with its own set of coordinates that are different from every other location. The column Location represents the state and county, followed by the SiteCode from the database, then a brief description of the location. The column UTM's gives the coordinates in Universal Transmercator, Datum83, UTM Zone 16 North. Column Lat/Lon gives the geographic coordinates in decimal degree format. The final column Elevation provides the elevation above sea level in meters (m).

Most locations were sampled twice. Each sampling occasion is called an event and is distinguished from every other event at the same location by its date, or the collection methods used, and/or by the collectors who took the sample. Following each Location record the events are listed subsequently by date, followed by collection method, and by collector(s).

Location	UTMs	Lat\Lon	Elevation
NC:Guilford Co., GUCO CAVALRY, unnamed stream at footbridge from trail at bathroom area to confluence with Cavalry Monument	3999431N 604383E	36.13398°N 79.83989°W	246 m
Event 01: 21-22 Jun 2007, black light trap, JLRobinson & CRParker			
NC:Guilford Co., GUCO Hunting Creek North, Hunting Ck at cnfl unnamed strm, ca 65 m S Loop Rd culvert	3999616N 604593E	36.13561°N 79.83753°W	245 m
Event 01: 11-12 Aug 2005, black light trap, CRParker			
Event 02: 21-22 Jun 2007, black light trap, JLRobinson & CRParker			
NC:Guilford Co., GUCO Hunting Creek South, Hunting Ck upstrm culvert Tour Rd, S side	3999350N 604625E	36.13322°N 79.83721°W	244 m
Event 01: 11-12 Aug 2005, black light trap, CRParker			
Event 02: 21-22 Jun 2007, black light trap, JLRobinson & CRParker			
NC:Guilford Co., GUCO Stop 5 Meadow Stream, Stop 5 (obelisk) small intermittent stream running through meadow down slope of parking lot	3999328N 604308E	36.13306°N 79.84074°W	254 m
Event 01: 13 Mar 2006, by hand, JLRobinson			
Event 02: 26 Feb 2007, beating, JLRobinson			
NC:Guilford Co., GUCO unnamed stream spring, spring fed stream, ca 15m N Loop Road, 50 m past tour stop 3	3999006N 604147E	36.13016°N 79.84257°W	259 m
Event 01: 11 Aug 2005, by hand, CRParker			
Event 02: 11-12 Aug 2005, black light trap, CRParker			
NC:Guilford Co., GUCO unnamed stream, stream 50 m past tour stop 3 100 m downstream of Tour Rd	3999178N 604222E	36.13171°N 79.84171°W	259 m
Event 01: 11-12 Aug 2005, black light trap, CRParker			
Event 02: 21-22 Jun 2007, black light trap, JLRobinson & CRParker			

Guilford Courthouse National Military Park



Appendix 2. Target Species Data

Data for Ephemeroptera, Odonata, Plecoptera, Megaloptera, and Trichoptera are presented below. Each record consists of the order, family, taxon name, and the number and type of specimens, arranged by collecting location and event. Many specimens could not be identified to species and are presented as, for example, *Perlesta* species. Adult specimens are identified in the table by the ♂ (male) and ♀ (female) symbols, larvae by the words “larva” or “larvae” and pupae by the words “pupa” and “pupae”.

Guilford Courthouse National Military Park			
Ephemeroptera, Odonata, Plecoptera, Megaloptera, and Trichoptera			
Order	Family	Species	Specimens
NC:Guilford Co., GUCO CAVALRY, 21-22 Jun 2007, black light trap			
Ephemeroptera	Heptageniidae	<i>Maccaffertium modestum</i> (Banks, 1910)	3 ♂
		<i>Stenacron interpunctatum</i> (Say, 1839)	6 ♂
Plecoptera	Perlidae	<i>Eccoptura xanthenes</i> (Newman, 1828)	2 ♂
		<i>Perlesta</i> species	1 ♀
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	17 ♂
		<i>Cheumatopsyche</i> species	31 ♂
		<i>Diplectrona</i> species	several ♂
		<i>Hydropsyche betteni</i> Ross, 1938	8 ♂
		<i>Hydropsyche sparna</i> Ross, 1938	1 ♂
		Lepidostomatidae	<i>Lepidostoma latipenne</i> (Banks, 1905)
	Leptoceridae	<i>Oecetis</i> species	1 ♂
NC:Guilford Co., GUCO Hunting Creek North, 11-12 Aug 2005, black light trap			
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	54 ♂
		<i>Diplectrona</i> species	2 ♂
		<i>Hydropsyche betteni</i> Ross, 1938	3 ♂
	Hydroptilidae	<i>Hydroptila</i> species	2 ♀
		Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)
	<i>Oecetis inconspicua</i> (Walker, 1852)		5 ♂
	<i>Oecetis persimilis</i> (Banks, 1907)		3 ♀
	Phryganeidae	<i>Agrypnia vestita</i> (Walker, 1852)	1 ♂
	Psychomyiidae	<i>Lype diversa</i> (Banks, 1914)	1 ♀
NC:Guilford Co., GUCO Hunting Creek North, 21-22 Jun 2007, black light trap			
Ephemeroptera	Ephemeridae	<i>Hexagenia limbata</i> (Serville, 1829)	2 ♀
	Heptageniidae	<i>Stenacron interpunctatum</i> (Say, 1839)	1 ♂
	Leptophlebiidae	<i>Habrophlebiodes americana</i> (Banks, 1903)	1 ♂
Plecoptera	Chloroperlidae	<i>Sweltsa</i> species	1 ♀
	Perlidae	<i>Eccoptura xanthenes</i> (Newman, 1828)	4 ♂
		<i>Perlesta decipiens</i> (Walsh, 1862)	12 ♀
Trichoptera	Trichoptera	Trichoptera species	1 adult
NC:Guilford Co., GUCO Hunting Creek South, 11-12 Aug 2005, black light trap			
Ephemeroptera	Caenidae	<i>Caenis</i> species	2 ♂
	Heptageniidae	<i>Maccaffertium modestum</i> (Banks, 1910)	1 ♂
Odonata	Calopterygidae	<i>Calopteryx maculata</i> (Beauvois, 1805)	1 ♂
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	58 ♂
		<i>Cheumatopsyche pinaca</i> Ross, 1941	1 ♂
		<i>Diplectrona</i> species	2 ♂
		<i>Hydropsyche betteni</i> Ross, 1938	21 ♂
	Hydroptilidae	<i>Hydroptila hamata</i> Morton, 1905	1 ♂
		<i>Orthotrichia aegerfasciella</i> (Chambers, 1873)	3 ♂
	Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)	1 ♂
		<i>Oecetis ditissa</i> Ross, 1966	1 ♀
		<i>Oecetis inconspicua</i> (Walker, 1852)	5 ♂
<i>Oecetis persimilis</i> (Banks, 1907)		4 ♂	

Guilford Courthouse National Military Park

Survey of Aquatic Insects of the Cumberland Piedmont and Appalachian Highlands Monitoring Networks

Ephemeroptera, Odonata, Plecoptera, Megaloptera, and Trichoptera			
Order	Family	Species	Specimens
NC:Guilford Co., GUCO Hunting Creek South, 21-22 Jun 2007, black light trap			
Ephemeroptera	Heptageniidae	<i>Stenacron</i> species	1 ♀
Plecoptera	Perlidae	<i>Eccoptura xanthenes</i> (Newman, 1828)	1 ♂
		<i>Perlesta placida</i> (Hagen, 1861)	3 ♀
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	142 ♂
		<i>Cheumatopsyche</i> species	169 ♂
		<i>Diplectrona</i> species	few ♂
		<i>Hydropsyche betteni</i> Ross, 1938	21 ♂
		<i>Hydropsyche morosa</i> Hagen, 1861	1 ♂
		<i>Hydropsyche sparna</i> Ross, 1938	3 ♂
	Hydroptilidae	Hydroptilidae species	2 ♀
		<i>Orthotrichia aegerfasciella</i> (Chambers, 1873)	1 ♂
	Leptoceridae	<i>Oecetis persimilis</i> (Banks, 1907)	2 ♂
Polycentropodidae	<i>Nyctiophylax denningi</i> JC Morse, 1972	1 ♂	
Trichoptera	Trichoptera species	1 adult	
NC:Guilford Co., GUCO Stop 5 Meadow Stream, 13 Mar 2006, by hand			
Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> species	4 pupae
	Rhyacophilidae	<i>Rhyacophila acutiloba</i> Morse & Ross, 1971	4 larvae
	Thremmatidae	<i>Neophylax atlanta</i> Ross, 1947	2 larvae
		<i>Neophylax oligius</i> Ross, 1938	3 larvae
NC:Guilford Co., GUCO Stop 5 Meadow Stream, 26 Feb 2007, beating			
Plecoptera	Capniidae	<i>Allocapnia rickeri</i> Frison, 1942	9 ♂
Trichoptera	Rhyacophilidae	<i>Rhyacophila nigrita</i> group	3 larvae
NC:Guilford Co., GUCO unnamed stream spring, 11 Aug 2005, by hand			
Odonata	Aeshnidae	<i>Boyeria vinosa</i> (Say, 1839)	1 larva
Plecoptera	Leuctridae	<i>Leuctra</i> species	1 larva
Trichoptera	Hydropsychidae	<i>Diplectrona modesta</i> Banks, 1908	4 pupa
	Thremmatidae	<i>Neophylax ornatus</i> Banks, 1920	6 larvae
NC:Guilford Co., GUCO unnamed stream spring, 11-12 Aug 2005, black light trap			
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	4 ♂
		<i>Diplectrona</i> species	2 ♂
	Hydroptilidae	<i>Hydroptila hamata</i> Morton, 1905	1 adult
		<i>Hydroptila</i> species	9 ♀
	Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)	2 ♂
	Polycentropodidae	<i>Polycentropus blicklei</i> Ross & Yamamoto, 1965	1 ♂
	Psychomyiidae	<i>Lype diversa</i> (Banks, 1914)	1 ♀
NC:Guilford Co., GUCO unnamed stream, 11-12 Aug 2005, black light trap			
Odonata	Libellulidae	<i>Libellula vibrans</i> Fabricius, 1793	1 ♀
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	4 ♂
		<i>Diplectrona</i> species	2 ♂
		<i>Hydropsyche betteni</i> Ross, 1938	1 ♂
	Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)	2 ♂
	Psychomyiidae	<i>Lype diversa</i> (Banks, 1914)	1 ♀
NC:Guilford Co., GUCO unnamed stream, 21-22 Jun 2007, black light trap			
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	7 ♂
		<i>Diplectrona</i> species	5 adults
	Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)	1 ♀

Appendix 3. Non-Target Species Data

The records for non-target taxa from Guilford Courthouse National Military Park (GUCO) are presented in the table below, organized by collection location and event. All non-target specimens collected during this survey are listed, except those that remain unsorted and unidentified. Those reported here represent 2 phyla, 3 classes, 5 orders, 11 families, and 14 genera. Some taxa are included in catchall groups that represent specimens that the authors did not identify. These are indicated in the table by entries such as “Amphipoda species”. Terrestrial species are highlighted in the table by a tan background.

Guilford Courthouse National Military Park						
Non-Target Taxa Specimen Records						
Phylum	Class	Order	Family	Taxon	Specimen	
NC:Guilford Co., GUCO CAVALRY, 21-22 Jun 2007, black light trap, JLRobinson & CRParker						
Arthropoda	Insecta	Mecoptera	Bittacidae	<i>Bittacus pilicornis</i> Westwood, 1846	1 ♂	
		Neuroptera	Chrysopidae	Chrysopidae species	1 adult	
NC:Guilford Co., GUCO Hunting Creek North, 11-12 Aug 2005, black light trap, CRParker						
Arthropoda	Insecta	Hymenoptera	Formicidae	Formicidae species	10 workers	
		Neuroptera	Mantispidae	Mantispidae species	1 adult	
NC:Guilford Co., GUCO Hunting Creek North, 21-22 Jun 2007, black light trap, JLRobinson & CRParker						
Arthropoda	Insecta	Coleoptera	Coleoptera	Coleoptera species	1 adult	
			Dytiscidae	<i>Copelatus glyphicus</i> (Say, 1823)	1 ♀	
		Mecoptera	Bittacidae	<i>Bittacus pilicornis</i> Westwood, 1846	1 ♂	
NC:Guilford Co., GUCO Hunting Creek South, 11-12 Aug 2005, black light trap, CRParker						
Arthropoda	Insecta	Orthoptera	Gryllidae	<i>Eunemobius carolinus</i> (Scudder, 1877)	1 ♂	
NC:Guilford Co., GUCO Hunting Creek South, 21-22 Jun 2007, black light trap, JLRobinson & CRParker						
Arthropoda	Insecta	Blattaria	Blatellidae	<i>Parcoblatta virginica</i> (Brunner, 1865)	1 adult	
		Mecoptera	Bittacidae	<i>Bittacus pilicornis</i> Westwood, 1846	1 ♂	
				<i>Bittacus strigosus</i> Hagen, 1861	1 ♂	
NC:Guilford Co., GUCO unnamed stream spring, 11 Aug 2005, by hand, CRParker						
Arthropoda	Insecta	Diptera	Chironomidae	Chironomidae species	12 larvae	
		Hymenoptera	Formicidae	Formicidae species	2 workers	
	Malacostraca	Amphipoda	Amphipoda	Amphipoda species	1 indiv.	
		Isopoda	Isopoda	Isopoda species	3 indivs.	
NC:Guilford Co., GUCO unnamed stream spring, 11-12 Aug 2005, black light trap, CRParker						
Annelida	Oligochaeta	Oligochaeta	Oligochaeta	Oligochaeta species	1 indiv.	
Arthropoda	Insecta	Diptera	Ptychopteridae	<i>Ptychoptera</i> species	1 larva	
NC:Guilford Co., GUCO unnamed stream, 11-12 Aug 2005, black light trap, CRParker						
Arthropoda	Insecta	Orthoptera	Gryllidae	<i>Eunemobius carolinus</i> (Scudder, 1877)	1 ♀	

Appendix 4. Species List

A list of all taxa found to occur in Guilford Courthouse National Military Park (GUCO) based on field collections of the present study. A total of 42 taxa are listed, of which 38 are aquatic. Of the aquatic species, 36 are target species, including 5 Ephemeroptera, 3 Odonata, 6 Plecoptera, and 22 Trichoptera. Terrestrial species are indicated by a tan highlight in the table. The tables include the genus, the species epithet, and the author, such as *Parcoblatta virginica* (Brunner, 1865). Entries such as *Caenis* species indicate a taxon, in this case a genus of mayfly, that was collected, but that could not be identified to species and for which no other representatives of the genus were found that could be identified to species. Since the genus *Caenis* is clearly present in the park, this entry is included to recognize the presence of the genus in GUCO.

Common names are provided in the tables. The Odonata and Plecoptera have “official” common names that are in widespread use and are generally widely accepted. For a separate project, we created common names for some mayflies and caddisflies. These names are included here. Most insect and other invertebrate groups do not have “official” common names for different species. For those groups, only a few species have common names. The names provided for the rest of the species are names that apply to genera, families, or orders, or in some cases to higher taxonomic categories.

List of all taxa collected in Guilford Courthouse National Military Park (GUCO). Entries such as “*Ptychoptera* species” indicate a genus that was represented only by individuals that could not be identified to species, but otherwise represent the only record of that genus from the GUCO.

Order	Family	Taxon	Common Name
Blattaria	Blatellidae	<i>Parcoblatta virginica</i> (Brunner, 1865)	Virginia Wood Cockroach
Coleoptera	Dytiscidae	<i>Copelatus glyphicus</i> (Say, 1823)	Predaceous Diving Beetle
Diptera	Ptychopteridae	<i>Ptychoptera</i> species	Phantom Crane Fly
Ephemeroptera	Caenidae	<i>Caenis</i> species	Small Squaregill Mayfly
	Ephemeridae	<i>Hexagenia limbata</i> (Serville, 1829)	Common Burrowing Mayfly
	Heptageniidae	<i>Maccaffertium modestum</i> (Banks, 1910)	Flat-headed Mayfly
		<i>Stenacron interpunctatum</i> (Say, 1839)	Flat-headed Mayfly
	Leptophlebiidae	<i>Habrophlebiodes americana</i> (Banks, 1903)	Pronggill Mayfly
Mecoptera	Bittacidae	<i>Bittacus pilicornis</i> Westwood, 1846	Hanging Scorpionfly
		<i>Bittacus strigosus</i> Hagen, 1861	Hanging Scorpionfly
Odonata	Aeshnidae	<i>Boyeria vinosa</i> (Say, 1839)	Fawn Darner
	Calopterygidae	<i>Calopteryx maculata</i> (Beauvois, 1805)	Ebony Jewelwing
	Libellulidae	<i>Libellula vibrans</i> Fabricius, 1793	Great Blue Skimmer
Orthoptera	Gryllidae	<i>Eunemobius carolinus</i> (Scudder, 1877)	Carolina Ground Cricket
Plecoptera	Capniidae	<i>Allocapnia rickeri</i> Frison, 1942	Midwest Snowfly
	Chloroperlidae	<i>Sweltsa</i> species	Sallfly
	Leuctridae	<i>Leuctra</i> species	Needlefly
	Perlidae	<i>Eccoptura xanthenes</i> (Newman, 1828)	Yellow Stone
		<i>Perlesta decipiens</i> (Walsh, 1862)	Widespread Stone
		<i>Perlesta placida</i> (Hagen, 1861)	Freckled Stone
Trichoptera	Hydropsychidae	<i>Cheumatopsyche analis</i> (Banks, 1903)	Retreat-making Caddisfly
		<i>Cheumatopsyche pinaca</i> Ross, 1941	Retreat-making Caddisfly
		<i>Diplectrona modesta</i> Banks, 1908	Retreat-making Caddisfly
		<i>Hydropsyche betteni</i> Ross, 1938	Retreat-making Caddisfly
		<i>Hydropsyche morosa</i> Hagen, 1861	Retreat-making Caddisfly
		<i>Hydropsyche sparna</i> Ross, 1938	Retreat-making Caddisfly
	Hydroptilidae	<i>Hydroptila hamata</i> Morton, 1905	Micro-caddisfly
		<i>Orthotrichia aegerfasciella</i> (Chambers, 1873)	Micro-caddisfly

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Lepidostomatidae	<i>Lepidostoma latipenne</i> (Banks, 1905)	Scale-mouthed Caddisfly
Leptoceridae	<i>Oecetis cinerascens</i> (Hagen, 1861)	Long-horned Caddisfly
	<i>Oecetis ditissa</i> Ross, 1966	Long-horned Caddisfly
	<i>Oecetis inconspicua</i> (Walker, 1852)	Long-horned Caddisfly
	<i>Oecetis persimilis</i> (Banks, 1907)	Long-horned Caddisfly
	<i>Trienodes ignitus</i> (Walker, 1852)	Long-horned Caddisfly
Phryganeidae	<i>Agrypnia vestita</i> (Walker, 1852)	Phryganeid Caddisfly
Polycentropodidae	<i>Nyctiophylax denningi</i> JC Morse, 1972	Fine-net Caddisfly
	<i>Polycentropus blicklei</i> Ross & Yamamoto, 1965	Fine-net Caddisfly
Psychomyiidae	<i>Lype diversa</i> (Banks, 1914)	Fine-net Caddisfly
Rhyacophilidae	<i>Rhyacophila acutiloba</i> Morse & Ross, 1971	Free-living Caddisfly
Thremmatidae	<i>Neophylax atlanta</i> Ross, 1947	Dog-faced Caddisfly
	<i>Neophylax oligius</i> Ross, 1938	Dog-faced Caddisfly
	<i>Neophylax ornatus</i> Banks, 1920	Dog-faced Caddisfly

Appendix 5. Species of Interest

Many of the species found during this survey are of particular interest because of their rarity, conservation ranking, sensitivity to pollution and disturbance, or unique habitat requirements. These taxa may warrant special attention in management considerations affecting aquatic habitats, and thus are presented in the tables below with additional information about their biology, distribution, and sensitivity, that might be helpful to managers.

The 194 species included in the tables were selected on the basis of the following criteria: 1) they are known from only one, two, or three parks, and thus are considered rare for this study; 2) they have a NatureServe global rank of G1, G2, or G3, or a state conservation rank of S1, S2, or S3 for any one of the seven states in the study area; 3) they have a tolerance value of 3.0 or less; or 4) they have special habitat requirements that may result in their being potentially at risk in the parks.

1) Number of parks - One of the purposes of the larger study is to assess the role of the parks as conservation reserves for aquatic species in the region, and species that are found in three or fewer of the parks (<17%) are potentially more at risk than species that occur in a larger number of parks. Therefore, highlighting those species and the parks in which they occur may serve to alert managers to the possible need for greater scrutiny of the environmental concerns connected with those species and their habitats. The parks and their official NPS acronyms are listed here. Of course, the occurrence of species in the parks is partially a function of the number of samples that have been taken in each park (e.g., the number of collecting trips, monitoring programs, historic interest by scientists, and so on). Thus, since many more samples have been taken in GRSM, including a long history of visits by aquatic entomologists dating back decades, many species are recorded from there that are not known from any other park. Some of these species have widespread distributions in the study area, and almost certainly occur in other parks. Only further sampling will overcome this problem. We know some records of species in the parks from the literature, and where such records are known for a park, a superscript (L) is appended to the park's acronym. Thus, BISO^(L) indicates that a record for BISO is based, at least in part or perhaps entirely, on a literature reference.

2) Conservation rankings - Conservation rankings are coded systems in which species' vulnerability to extinction are assessed and rated on wide geographic scales, such as global, which covers the entire range of a species, or national, which assess the species' vulnerability to extinction with a country. NatureServe maintains a list in which species have been evaluated in a standardized and hopefully objective manner, and assigned a rank that reflects each species' vulnerability. In this system, species are assigned ranks

Appalachian Highlands Monitoring Network

• BISO	Big South Fork National River and Recreation Area
• BLRI	Blue Ridge Parkway
• GRSM	Great Smoky Mountains National Park
• OBRI	Obed Wild and Scenic River

Cumberland Piedmont Monitoring Network

• ABLI	Abraham Lincoln Birthplace National Historic Site
• CARL	Carl Sandburg Home National Historic Site
• CHCH	Chickamauga and Chattanooga National Military Park
• COWP	Cowpens National Battlefield
• CUGA	Cumberland Gap National Historic Park
• FODO	Fort Donelson National Battlefield
• GUCO	Guilford Courthouse National Military Park
• KIMO	Kings Mountain National Military Park
• LIRI	Little River Canyon National Preserve
• MACA	Mammoth Cave National Park
• NISI	Ninety Six National Historic Site
• RUCA	Russell Cave National Monument
• SHIL	Shiloh National Military Park
• STRI	Stones River National Battlefield

according to the criteria given in Table A -1. Many state conservation agencies have adopted a very similar system of ranking the conservation status of state species. In the tables below, state ranks are presented as, for example, ALS2 or TNS1, for Alabama state ranking of S2 and Tennessee state ranking of S1, respectively. The evaluation by NatureServe or any of the states in the study area that a species' rank is 1, 2, or 3 is justification for that species to be listed in the tables below.

Table A -1. The three most critical ranks in the Association for Biodiversity Information global system used in this study. Other ranks are included in the NatureServe system, but those are not used here.

Rank	Definition
G1	Critically imperiled — Critically imperiled globally because of extreme rarity or because of some factor(s) making it extremely vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2	Imperiled — Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individual (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).
G3	Vulnerable — Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations) or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

3) Tolerance values - Tolerance values are numbers assigned to taxa based on empirical assessments of how sensitive different taxa are to various forms of pollution or habitat disturbance (i.e., (Barbour and others, 1999; Blocksom and Winters, 2006; Klemm and others, 2003; Lenat, 1988). Most systems use values in the range of 0-10, in which 0 represents those taxa which are highly sensitive to pollution and tend to be the first taxa to be eliminated from a polluted system, and 10 represents those taxa which are most tolerant of pollution and become the most common taxa in heavily polluted systems. Tolerance values are considered valuable when biologists sample communities, and assess the species found in each community as a function of the tolerance values and the relative abundances of the species encountered. This normally leads to an index of biotic integrity, or IBI, which is taken as a direct measure of how healthy, or stressed, a community is at the time it was sampled. Various rating systems are in use in the study region, so we have adopted the system used by the North Carolina Department of Environment and Natural Resources ((North Carolina Biological Assessment Unit, 2006)) wherever possible. Some taxa are not represented in the NC system. For those species, we examined the tolerance values listed by the Tennessee Division of Water Pollution Control (Arnwine, 2006)) or the Kentucky Division of Water (Kentucky Division of Water, 2009)), and if a taxon was listed in one of those two sources, we used that tolerance value. If a taxon was not found in these sources, we searched the EPA biomonitoring protocol manual (Barbour and others, 1999), which lists tolerance values for several regions, including NC. If that list included a value for a taxon not found in the NC, TN, or KY systems we accepted the tolerance value in the following preference sequence: Mid-Atlantic (MACS), Midwest (OH), Upper Midwest (WI). Taxa not having any tolerance value from one of these sources are indicated in the tables with an entry of 'n/a.'

4) Special habitat requirements – Unique habitat requirements include isolated springs and bogs, madicolous and hygropetric

habitats, and semi-terrestrial habitats. Some of these habitats are on the peripheries of more readily recognized aquatic habitats, and thus may not be seen as unique or vulnerable habitats. For example, small rockface seeps, often found along roadways, are unique habitats for a number of species specialized on the madicolous habitat, in which the larvae (rarely the adult) live in a thin film of water flowing over the nearly vertical face of the rocks. Such habitats, particularly if found along a roadway, are subject to loss of shading because of the open nature of roadways, roadside mowing operations, and paving of the drainage ditches they flow into. Other organisms live not in streams or seeps, but rather along the periphery of such habitats, in the leaf litter and under or among the rocks and soils around the edges. These species are vulnerable to trampling by visitors and park employees, exotic animals such as European wild boars that root in these places, and other activities that may open up the habitats and lead to excessive drying of the edges. Species which have special habitat requirements therefore are also included in the tables, with entries in the Comments row below the species' entry row.

Additional information is provided in the tables, as well. This includes the elevation range at which each species was found during our surveys. We did not have elevations for a small number of localities, and therefore a small number of species do not have elevations reported in the tables. The list of US and Mexican states and Canadian provinces in which each species has been recorded is listed, in as far as is known. Adult flight periods are reported for adult specimens collected during this study, followed in parentheses by flight periods reported in the literature. Specimens collected during this study only as immatures do not have a flight period, although, wherever possible a flight period is reported based on literature references. Some species in the tables are based on literature records that did not include any additional information, and for those species some of the entries are listed as “n/a”.

Following each species record is a Comments record, which contains biological and ecological information about the species based on the authors' knowledge and reports in the literature. Information in this row may include details on food, growth, habitat, behavior, mating, egg-laying, parasites, rarity, endemism, and points of interest.

For each genus, the first listing in square brackets [] is the summary Habitat, Habit, and Trophic Relationships from the summary tables at the end of each taxon chapter in Merritt and others, (2008a). These summaries are valuable, concise statements of the basic known ecological characteristics of each genus. The meanings of the entries are explained in the tables below, which are from tables 6A, 6B, and 6C of Merritt and others (2008b).

Table A -2. Aquatic habitat classification system. From Table 6A of Merritt and others (2008b).		
General Category	Specific Category	Description
Lotic erosional (running-water riffles)	Sediments	Coarse sediments (cobbles, pebbles, gravel) typical of stream riffles.
	Vascular hydrophytes	Vascular plants growing on (e.g., moss <i>Fontinalis</i>) or among (e.g., pondweed <i>Potamogeton pectinatus</i>) coarse sediments in riffles.
	Detritus	Leaf packs (accumulations of leaf litter and other coarse particulate detritus at leading edge or behind obstructions such as logs or large cobbles and boulders) and debris (e.g., logs, branches) in riffles.
Lotic depositional	Sediments	Fine sediments (sand and silt) typical of stream pools and margins.
	Vascular hydrophytes	Vascular plants growing in fine sediments (e.g., <i>Elodea</i> , broad-leaved species of <i>Potamogeton</i> , <i>Ranunculus</i>).

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	Detritus	Leaf litter and other particulate detritus in pools and alcoves (backwaters).
Lentic limnetic (standing water)	Open water	On the surface or in the water column of lakes, bogs, ponds.
Lentic littoral (standing water, shallow shore area)	Erosional	Wave-swept shore area of coarse (cobbles, pebbles, gravel) sediments.
	Vascular hydrophytes	Rooted or floating (e.g., duckweed <i>Lemna</i>) aquatic vascular plants (usually with associated macroscopic filamentous algae).
	Emergent zone	Plants on the immediate shore area, e.g., <i>Typha</i> (cattail), with most of the leaves above water.
	Floating zone	Rooted plants with large floating leaves, e.g., <i>Nymphaea</i> (pond lily), and non-rooted plants (e.g. <i>Lemna</i>).
	Submerged zone	Rooted plants with most leaves beneath the surface.
	Sediments	Fine sediments (sand and silt) of the vascular plant beds.
Lentic profundal (standing water, basin)	Sediments	Fine sediments (fine sand, silt and clay) mixed with organic matter of the deeper basins of lakes.
Beach zone	Freshwater lakes	Moist sand beach areas of large lakes.

Table A -3. Categorization of aquatic insect habits (mode of existence). From Table 6B of Merritt and others (2008b).

Category	Description
Skaters	Adapted for “skating” on the surface where they feed as scavengers on organisms trapped in the surface film (example: Hemiptera: Gerridae – water striders).
Swimmers	Adapted for “fishlike” swimming in lotic or lentic habitats. Individuals usually cling to submerged objects, such as rocks (lotic riffles) or vascular plants (lentic), between short bursts of swimming (examples: Ephemeroptera: Siphonuridae, Leptophlebiidae).
Clingers	Representatives have behavioral (e.g., fixed retreat construction) and morphological (e.g., long, curved tarsal claws, dorsoventral flattening, and ventral gills arranged as a sucker) adaptations for attachment to surfaces in stream riffles and wave-swept rocky littoral zones of lakes (examples: Ephemeroptera: Heptageniidae; Trichoptera: Hydropsychidae; Diptera: Blephariceridae).
Sprawlers	Inhabiting the surface of floating leaves of vascular hydrophytes or fine sediments, usually with modification for staying on top of the substrate and maintaining the respiratory surfaces free of silt (examples: Ephemeroptera: Caenidae; Odonata: Libellulidae).
Climbers	Adapted for living on vascular hydrophytes or detrital debris (e.g., overhanging branches, roots and vegetation along streams, and submerged brush in lakes) with modifications for moving vertically on stem-type surfaces (examples: Odonata: Aeshnidae).
Burrowers	Inhabiting the fine sediments of streams (pools) and lakes. Some construct discrete burrows which may have sand grain tubes extending above the surface of the substrate or individuals may ingest their way through the sediments (examples: Ephemeroptera: Ephemeridae - burrowing mayflies; Diptera: most Chironominae, Chironomini - “blood worm” midges). Some burrow (tunnel) into plant stem, leaves, or roots (miners).

Table A -4. General classification system for aquatic insect trophic relations. (Applicable only to immature and adult stages that occur in the water.) From Table 6C of Merritt and others (2008b).

Functional Group (General category based on feeding mechanism)	SUBDIVISION OF FUNCTIONAL GROUP		General Particle Size Range of Food (microns)
	Dominant Food	Feeding Mechanism	
Shredders	Living vascular hydrophyte tissue	Herbivores – chewers and miners of live macrophytes	
	Decomposing vascular plant tissue – coarse particulate organic matter (CPOM)	Detritivores – chewers of CPOM	>10 ³
	Wood	Gougers – excavate and gallery, wood	
Collectors	Decomposing fine particulate organic matter (FPOM)	Detritivores – filterers or suspension feeders	
		Detritivores – gatherers or deposit (sediment) feeders (includes feeders on loose surface films)	<10 ³
Scrapers	Periphyton – attached algae and associated material	Herbivores – grazing scrapers of mineral and organic surfaces	<10 ³
Macrophyte Piercers	Living vascular hydrophyte cell and tissue fluids or filamentous (macroscopic) algal cell fluids	Herbivores – pierce tissues or cells and suck fluids	>10 ⁻² – >10 ³
Predators	Living animal tissue	Engulfers – carnivores, attach prey and ingest whole animals or parts	>10 ³
		Piercers – carnivores, attack prey, pierce tissues and cells, and suck fluids	

Two letter abbreviations are used in the columns labeled States. These are based on the standard US Postal Service and Canadian Postal Service abbreviations. Mexican states and Central American country abbreviations follow those used in various publications. The complete list of abbreviations is given in the table below.

Table A -5. Postal codes used in the Species of Interest tables.

States of United States of America			
Code	State	Code	State
AL	Alabama	MT	Montana
AK	Alaska	NE	Nebraska
AZ	Arizona	NV	Nevada
AR	Arkansas	NH	New Hampshire
CA	California	NJ	New Jersey
CO	Colorado	NM	New Mexico
CT	Connecticut	NY	New York

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Code	State	Code	State
DE	Delaware	NC	North Carolina
DC	District of Columbia	ND	North Dakota
FL	Florida	OH	Ohio
GA	Georgia	OK	Oklahoma
HI	Hawaii	OR	Oregon
ID	Idaho	PA	Pennsylvania
IL	Illinois	RI	Rhode Island
IN	Indiana	SC	South Carolina
IA	Iowa	SD	South Dakota
KS	Kansas	TN	Tennessee
KY	Kentucky	TX	Texas
LA	Louisiana	UT	Utah
ME	Maine	VT	Vermont
MD	Maryland	VA	Virginia
MA	Massachusetts	WA	Washington
MI	Michigan	WV	West Virginia
MN	Minnesota	WI	Wisconsin
MS	Mississippi	WY	Wyoming
MO	Missouri		
States of Mexico – only those actually used below are listed here			
Code	State	Code	State
AG	Aguascalientes	MX	Unspecified location in the country of Mexico
BN	Baja California Norte (Official code is BC. This conflicts with British Columbia, Canada, and is here replaced with BN.)	OA	Oaxaca
BS	Baja California Sur	PU	Puebla
CH	Chihuahua	QT	Queretaro
CL	Colima	SI	Sinaloa
CS	Chiapas	SL	San Luis Potosi
DF	Distrito Federal	SO	Sonora
DG	Durango	TM	Tamaulipas
JA	Jalisco	VE	Veracruz
ML	Morelos (The official code is MO, which conflicts with Missouri. We have replaced it here with ML.)		

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Provinces of Canada			
Code	Province	Code	Province
AB	Alberta	NS	Nova Scotia
BC	British Columbia	NU	Nunavut
LB	Labrador (Politically, Labrador is part of Newfoundland. However, for biogeographic reasons, we list it separately here as LB.)	ON	Ontario
MB	Manitoba	PE	Prince Edward Island
NB	New Brunswick	QC	Quebec
NL	Newfoundland (This refers to the island portion of Newfoundland.)	SK	Saskatchewan
NT	Northwest Territories	YT	Yukon

Central American Countries			
Abbreviation	Country	Abbreviation	Country
BE	Belize	HO	Honduras
CR	Costa Rica	MR	Montserrat
GU	Guatemala	NI	Nicaragua

On-Line Resources

Much useful information incorporated into the tables below came from web sites maintained by various authorities. These include:

- Barber-James, H., M. Sartori, J.-L. Gattolliat, and J. Webb. 2013. World checklist of freshwater Ephemeroptera species. <http://FADA.biodiversity.be/group/show/35>
- DeWalt, R. E., U. Neu-Becker and G. Stueber. 2010. Plecoptera Species File Online. Version 1.1/4.0. <http://Plecoptera.SpeciesFile.org> Accessed on 17 Dec 2010.
- Freshwater Animal Diversity Assessment (FADA) Project. 2010. <http://FADA.biodiversity.be> Accessed on 17 Dec 2010.
- McCafferty, P. W. (Editor). 2010. Mayfly Central. <http://www.entm.purdue.edu/mayfly/index.php> Accessed on 17 Dec 2010.
- Morse, John C. (Editor). 2010. Trichoptera World Checklist. <http://entweb.clemson.edu/database/trichopt/> Accessed on 17 Dec 2010.
- National Museum of Natural History, The Netherlands, <http://www.odonata.info/odonata/odonata/tree.html> Accessed on 17 Dec 2010.
- Oswald, J. D. (chief editor). Lacewing Digital Library. <http://lacewing.tamu.edu/> Accessed on 17 Dec 2010.

ORDER EPHEMEROPTERA HYATT & ARMS

MAYFLIES

Mayflies are cosmopolitan, being found on every continent except Antarctica. Slightly more than 3300 species are known, distributed in 42 families, and more than 430 genera (Barber-James and others, 2008). The highest numbers of species are found in the Palearctic region (790), followed by the Nearctic (650), and the Neotropical (607). It is likely that the tropical component of the order is underrepresented in this compilation due to the historical bias in systematic surveys that have emphasized the Northern Hemisphere (Balian and others, 2008). In the Western Hemisphere, mayflies are found from near the Arctic Circle south through Mexico, and on into Central and South America. With approximately 650 species in 20 or more families and more than 100 genera in North America (Canada, the United States, and the non-tropical portions of Mexico), the Nearctic has one of the richest faunas described to this point. During this survey, we found 139 species in 44 genera and 12 families. In BISO, we found 57 species in 31 genera and 12 families.

Mayfly adults are delicate, small to medium size, two or four winged insects with two or three long tails, and, usually, with long legs. Adults often are seen flying about streams, rivers, ponds, and lakes. Mayflies are unable to fold their wings, which, therefore, are held vertically over the back of the insect when at rest. Many species have sexually dimorphic eyes, with the males having the upper facets enlarged, sometimes extremely so, and differently colored than the lower facets. Females never have the eyes modified in this manner. The larvae are aquatic and live in the habitats near where the adults are seen flying. Like the adults, the larvae have two or three caudal filaments, although the larva may have three while the adult of the same species has only two. The larval stage may last 3-4 weeks, or as long as 2½ years. Mayflies grow through a process called hemimetabolous development, which means that they do not pass through a pupal stage before becoming an adult. This type of development is found in many groups of insects including the Odonata and Plecoptera, which are also aquatic insects and are considered below. Larvae pass through many instars (10-50) before finally emerging as a subimago, a flying stage that exists between the larval and the full adult stages. Ephemeroptera are unique in that they are the only insects that have a flying stage before becoming sexually mature. The subimago stage may last from a few minutes to several days before molting to the reproductive imago (adult) stage. Subimagos are recognized by the opaque or cloudy condition of the wings, whereas the imago stage has transparent or hyaline wings. In a few species, the females mate and lay eggs as subimagos, and never molt to the true adult stage (Waltz & Burian 2008). Approximately 50 species of mayflies are known to be parthenogenetic, although only about half a dozen are obligately so. In facultatively parthenogenetic species, fertilized eggs mature more quickly and more successfully than unfertilized eggs (Brittain 1982). In obligately parthenogenetic species, eggs mature as rapidly and successfully as do fertilized eggs in sexual species. Mating normally occurs in the air, but a few species mate on a surface. Adults live just 1-2 hours or as long as 14 days. Adults do not feed. Eggs are always laid in water. Hatching may take place within minutes, or may be delayed for many months. Excellent general accounts of mayflies are found in Edmunds and others (1976), Brittain (1982), Unzicker and Carlson (1982), Berner and Pescador (1998), and Waltz and Burian (2008).

Mayflies play essential roles in aquatic ecosystems. Many species are herbivores or detritivores as nymphs, converting energy captured by plants and fungi into animal biomass, and they themselves are an important food source for other animals, both invertebrates and vertebrates. A few genera have carnivorous species that feed on small, soft-bodied invertebrates. Feeding usually stops in the penultimate (next to last) instar. Many mayflies are highly intolerant of human-caused pollutants and habitat disturbance, which makes them valuable indicators of the health of aquatic ecosystems.

Suborder Furcatergalia Kluge

the forked-gill mayflies

Infraorder Lanceolata McCafferty

the pronggills

Family Leptophlebiidae Banks

the pronggills

This is one of the largest families of mayflies, having more than 600 species in more than 130 genera throughout the world (Barber-James and others, 2008). In North America 87 species in 10 genera are known. We found 12 species in five genera in the study area. As the common name suggests, the larvae are characterized by having the abdominal gills variously divided into forks or prongs, either simply or elaborately but always distinctively.

Genus *Habrophlebiodes* Ulmer - [Habitat — Lotic erosional and depositional: Habit — Swimmers, clingers, sprawlers: Trophic — Scrapers, Collectors-gatherers] The genus *Habrophlebiodes* contains four species each in the Oriental and Nearctic Realms. Three species occur in the Southeast, one of which was found in the parks.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Habrophlebiodes americana</i> (N Banks, 1903)	BLRI, GRSM ^(L) , GUCO, KIMO, MACA	AL, IL, IN, KY, MX, NC, NH, NT, NY, OH, ON, QC, PU, QT, SC, TC, TN, VA, WI	212-1025 m	G5	1.0	6 June - 26 August (April - October)

Comments - A tolerance value of 1.0 is established for this species. Subimago and adult stages generally last less than 24 hours each. Larva up to 6 mm in length, forewing up to 6.5 mm. We have 13 collections and 32 specimens of this species.

ORDER ODONATA FABRICIUS

DRAGONFLIES AND DAMSELFLIES

The Odonata are commonly encountered aquatic insects throughout the world, being present on every continent except Antarctica. Dragonflies and damselflies consist of nearly 5700 species worldwide: more than 2900 species (in 12 families and 427 genera) are dragonflies (Suborder Anisoptera), and more than 2700 species (in 19 families and 352 genera) are damselflies (Suborder Zygoptera) (Kalkman and others, 2008). Odonata species richness is concentrated in the Neotropical and Indo-Malayan realms, which contain almost 60% of known species (Clausnitzer and others, 2009). In North America, there are 350 species of dragonflies in 5 families and 68 genera, and 161 species of damselflies in 8 families and 28 genera.

The adults are excellent and obvious fliers around lakes, ponds, swamps, rivers, and streams, in forested areas as well as in open plains. Many species are large, colorful, and exhibit fascinating behaviors, such as hunting for flying insect prey, patrolling a mating territory, or flying in tandem when mating and laying eggs. In addition, many species perch, that is they return to the same spots repeatedly to rest and remain there for several seconds to minutes at a time. Perching behavior makes it possible for patient photographers to approach and take pictures. Many excellent photographs of odonates illustrate a wide number of field guides, helping to enlighten and educate the public about the group. Like mayflies, odonates are unable to fold their wings and must hold them out to the sides or vertically over their backs when not flying. This, too, makes it easier for naturalists to get a good view of the insects.

One striking distinguishing characteristic of all odonates is their reproductive system that uses indirect sperm transfer. Males have two sets of genital organs; the primary genitalia are at the end of the abdomen, as in virtually all insects; and the secondary genitalia are on the underside of the second and third segments. To prepare for mating, a male bends his abdomen forward and connects the primary genitalia with the secondary genitalia. In this position, he transfers his sperm to the secondary genitalia. This may happen before a male wins a female, or after successful courting. When a male induces a female to mate, he holds her by her neck using the long appendages at the end of his abdomen. The female then curls her abdomen forward and connects with the male's secondary genitalia on the second abdominal segment. The pair may be perched or flying while mating, which may last a minute or two, or an hour or more. Normally, the male continues to hold the female until she finishes laying her eggs. However, other males may try to dislodge the pair and take the female. So guarding behavior by the successful male is often necessary to ensure the eggs are fertilized and laid using his sperm. Eggs are laid using several techniques, including ovipositing into the stems of aquatic plants or even into logs. Those groups which oviposit into plant material have a well-developed ovipositor. All damselflies and the dragonflies Aeshnidae and Petaluridae have ovipositors. Some of the species which oviposit into plants, land on the plants and then back down the stem into the water to oviposit into the submerged portion of the plant, some times as much as 40 cm below the surface. Other species oviposit by dipping the abdomen into water while flying over the surface and washing the eggs off. Hatching usually takes place 2-4 weeks after oviposition, but in some species the eggs enter a diapause in order to pass the winter as eggs which, then hatch in the spring. Odonate larvae pass through 5-15 molts. The larval stage may last a few months to three years, depending primarily on temperature and photoperiod. Most species in the study area have a univoltine life history. Larvae that are ready to molt to the adult stage can be recognized by their very dark wing pads, similar to the condition in mayfly larvae that are ready to molt to the subimago stage. The larvae crawl out of the water to transform. Some species remain very close to the water's edge, while others may move considerable distances from the water, even climbing high into trees to molt.

The larvae are less well known than the adults, but are no less fascinating. All odonate larvae are predaceous, and have a unique "lower lip" (labium) that functions as a prey grabbing instrument. This lower lip is hinged and has highly modified components armed with teeth, spines, and setae. Larvae hunt either actively by climbing about looking for prey, or by hiding in the substrate and ambushing prey when they pass close by. When a larva attacks a prey item, it juts its labium forward toward the prey at enormous speed. The palps of the labium grab the prey, securing it with the spines and jerking it back to the mouth to be eaten. In some larvae the labium is flat and held under the head, while in others it is cupped and held in front of the face, resembling a toothed mask.

Odonata are integral parts of their ecosystems. In many habitats, the larvae are the top predators in freshwater ecosystems, feeding on virtually anything

that moves and is smaller than they are. In turn, many fish feed on dragonfly and damselfly larvae. Larvae also have specific habitat requirements, and thus have the potential to be important indicator species. They are generally more tolerant of pollution and habitat disturbance than are mayflies, as is reflected in the tolerance values assigned in the tables below. As adults, dragonflies and damselflies are persistent predators of other adult aquatic and terrestrial insects, feeding frequently over an adult life span that may last many weeks. And, they also become the prey of larger hunters, such as birds.

Many field guides and books are available to aid in identifying odonates in both the larval and adult stages, and provide valuable information on habitats, habits, and other biological details. The following references were used in developing these tables: Beaton (2007), Huggins & Brigham (1982), Needham and others, (2000), Westfall & May (1996), Tennessen (2008).

Suborder Anisoptera Selys

Dragonflies

Adult dragonflies are easily distinguishable from adult damselflies by their larger size and stouter bodies, their close-set, very large eyes, and their broad hind wings that are shaped differently than the forewings. Dragonfly larvae are easily distinguished from damselfly larvae by the absence of three large, external gills at the end of the abdomen. Dragonflies have gills internally in the rectum, and live specimens can be seen “inhaling” and “exhaling” when observed carefully. If disturbed, the larvae can rapidly expel water from the rectum and jet away by the hydraulic force of this expulsion.

The taxonomic arrangement used here treats Corduliidae, Libellulidae, and Macromiidae as separate families. This differs from the treatment in Needham and others (2000), the most comprehensive manual for dragonfly identification for North America, in which Corduliinae and Macromiinae are considered as subfamilies of Libellulidae. The arrangement used here seems to be followed by most North American workers today.

Family Aeshnidae Rambur

darners

Darners are cosmopolitan, and include some of the largest dragonflies in the study area. The adults have very large eyes that meet at the top of the head. Most species are quite colorful, having green, blue, red, and brown body markings. Adults tend to fly high above the ground or water when feeding. Some species are known to migrate, generally from northern areas southward as the days cool and shorten. The larvae are slender and have limited setae (hairs) on the body. They crawl about the habitat, climbing over vegetation and debris, looking for prey. Larger individuals will feed on smaller individuals of the same species. The labium is flat in all species, never cupped into a mask. Prey of aeshnids sometimes includes tadpoles.

Worldwide more than 430 species are known, representing more than 50 genera. Approximately 47 species of darners are found in the Nearctic, distributed among 13 genera (Kalkman and others, 2008). We found 10 species in 8 genera in the parks.

Genus *Boyeria* McLachlan –

Spotted Darners

[Habitat — Lotic erosional and depositional (detritus, vascular hydrophytes): Habit — Climbers—sprawlers (clingers under rocks): Trophic — Predators (engulfers)] *Boyeria* is a northern genus. Two species are found in North America, and one each is found in Japan and Europe. We found both North American species in the parks.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Boyeria vinosa</i> (T Say, 1839) Fawn Darner	BISO ^(L) , BLRI, CARL, COWP, CUGA, GRSM ^(L) , GUCO , LIRI, OBRI	AL, AR, CT, DC, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, NB, NC, NE, NH, NJ, NS, NY, OH, OK, ON, PA, PE, QC, RI, SC, TN, TZ, VA, VT, WI, WV	259-987 m	G5, NCS3	5.9	1-31 Aug (May - Oct)
Comments — Larvae live in small to medium-sized forested streams, and in some localities are quite common in these habitats, hiding under rocks, logs, and similar large objects. It is considered vulnerable in North Carolina. Larva up to 37 mm in length, adult up to 71 mm. We found 590 specimens from 77 locations during our study, including a single larva from GUCO.						

Suborder Zygoptera Selys

Damselflies

Damselflies are delicate and small in comparison with their robust and large cousins, the dragonflies. Their bodies, in both larval and adult stages are elongate and slender. The larvae generally have long legs that, in some groups are stilt like. The wings are narrow at the bases and the front and hind wings are similar in shape, in contrast with those of dragonflies. Like dragonflies, the damselflies are carnivorous. The larvae have a hinged labium with a grasping mentum and palps for securing prey. Unlike dragonflies, they breathe with the aid of three external bladelike caudal gills. The gills make an excellent field recognition character for the recognition of damselfly larvae in the field. They are variable among and within groups, and often are very helpful in identification. The heads of adults are transverse, with prominent eyes. Many species are beautifully marked with bright, sometimes metallic colors. In some species the wings may be banded or have other markings. We collected 37 species, 9 genera, and 3 families of damselflies the parks. We collected a single specimen of *Calopteryx maculata* (Beauvois, 1805) from GUCO. However, this is not a species of concern for this study.

ORDER PLECOPTERA BURMEISTER

STONEFLIES

The stoneflies, Order Plecoptera, are hemimetabolous aquatic insects distributed worldwide. Approximately 3,500 species are known, distributed among 16 families and about 270 genera. As with virtually all insects, much more study has occurred in the Northern Hemisphere than in the Southern Hemisphere and more in the Temperate than in the Tropical realms. This, therefore, considerably biases our knowledge and understanding of the distribution, ecology, and biology of stoneflies. Current information indicates that stoneflies are largely restricted to cold, running waters. Only a relative handful is found in lakes or other lentic waters, and arid lands are virtually devoid of stoneflies (Fochetti & Tierno de Figueroa 2008). Stoneflies are weak fliers and poor dispersers – some adults lack functional wings – and coupled with their ecological limitations, tend to be highly restricted in distribution and to display a relatively high degree of endemism. Very few species are found on more than one continent or biogeographic region, and within regions distributions often are restricted to smaller geographic subdivisions. The greatest numbers of species are found in Asia (approximately 1,500 species [Fochetti & Tierno de Figueroa 2008]), the Nearctic (650 species), and Europe (420 species). It is likely that further study in the coming decades will almost double the number of known species of Plecoptera, with very many new taxa to be found in the tropical regions of the world (Fochetti & Tierno de Figueroa 2008).

The higher taxonomy of Plecoptera, like that of most insect groups, is not resolved to everyone's satisfaction. The taxonomy used here is the most widely used and is based on Zwick (1980, 2000), as reflected in Stewart & Stark (1988). Two suborders are recognized, only one of which, Arctoperlaria Zwick, is found in North America. The Arctoperlaria is subdivided into two groups, the Euholognatha Zwick and the Systellognatha Enderlein.

About 650 species of stoneflies are found in North America, in nine families and around 100 genera. Most North American stoneflies can be identified to genus, and in some genera, many species are identifiable, as well. In addition to Stewart & Stark (2008), an indispensable resource for stonefly larval taxonomy is Stewart & Stark (1984). A new series of publications on adult taxonomy, which includes keys to species, is the "Stoneflies (Plecoptera) of Eastern North America," volumes 1 and 2 (Stark & Armitage 2000, 2004).

Stark and others (1998, 2012) established common names for 693 species of Nearctic stoneflies. Each family is given a name, and every species in the family has a name that incorporates the family name. For example, the family Capniidae is called the Snowflies, and the species *Allocapnia formosa* Ricker, 1952, is called the Smokies Snowfly. Family and species names based on this system are given in the tables below.

Suborder Arctoperlaria Zwick

Group Euholognatha Zwick

Family Capniidae Klapálek

snowflies

This is one of the families of winter stoneflies, so called because the adults emerge in the winter months, principally from Nov through Mar. Male Snowflies are commonly brachypterous (short-winged) while the females have wings longer than the abdomen. Adults are dark brown to black, and may be seen crawling about on snow after emergence, accounting for the common name.

Genus *Allocapnia* Claassen - [Habitat — Lotic erosional (coarse sediments, wood, leaf packs) and depositional: Habit — Clingers: Trophic — Shredders detritivores] Approximately 40 species of *Allocapnia* are known from North America, and we found eight species in the parks. Males of most species have the wings shorter than the body, at least in some specimens, and sometimes males may be wingless. Females have fully developed wings that extend beyond the end of the abdomen. Snowflies often are found in springs, including those that frequently are dry a short distance from the source (Grubbs, 2011). Bouchard and others (2009) have shown that two species of *Allocapnia* (*A. granulata* and *A. pygmaea*), despite being winter stoneflies often found on snow, are not freeze tolerant. This finding may explain why adults are more commonly found in late winter and early spring. Larvae of *Allocapnia* cannot be identified to species at present, so the genus has been assigned a tolerance value of 2.5.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Allocapnia rickeri</i> Frison, 1942 Midwest Snowfly	GUCO	AL, AR, DC, DE, GA, IA, IL, IN, KS, KY, MD, MN, MO, MS, NC, NJ, NY, OH, OK, ON, PA, TN, VA, WI, WV	254 m	G5	2.5	26 Feb (Dec - Apr)

Comments – Our only record of this species is based on 9 males and 17 females from a small, intermittent stream downstream of the historical obelisk. Kondratieff et al. (1999) report that *Allocapnia rickeri* seems especially resilient to siltation and organic pollution.

Family Leuctridae Klapálek

needleflies

This family has just over 320 species worldwide, with about 60 known from North America. Adults are easily recognized in the field by their elongate, needle-like shape. They also are known as rolled-winged stoneflies because the wings appear to be wrapped about the length of the upper half of the body as a tube.

Subfamily Leuctrinae Klapálek

Genus *Leuctra* Stephens — [Habitat — Lotic erosional and depositional: Habit — Sprawlers clingers: Trophic — Shredders detritivores] This genus includes about 200 species worldwide, with nearly 30 species in North America. We found 17 species in the parks. Larvae are inseparable at this time; therefore, *Leuctra* species have been assigned a genus-level tolerance value of 0.7.

Comments — We found a single larva from an unnamed spring near tour stop 3.

Family Nemouridae Newman

forestflies

This is the second largest families of stoneflies, having more than 630 described species (Fochetti and Tierno de Figueroa, 2008). The largest number of species is known from the Oriental region, which is also considered one of the most poorly known areas for stoneflies. Approximately 80 species are known in North and Central America. No forestflies are found in South America. The Palaearctic has more than 130 species, and several genera are Holarctic. Baumann (1975) considered Nemouridae the dominant stonefly family in mountain-river ecosystems in terms of species and biomass. The larvae are detritivores.

Subfamily Nemourinae Newman

Genus *Soyedina* Ricker - [Habitat—Spring outflows: Habit — Sprawlers clingers: Trophic — Shredders detritivores] This genus is restricted to North America. Fewer than 10 species are known, although an undescribed species is known from GRSM. Larvae are found in clear cold streams at high elevations and adults emerge in the spring or early summer (Baumann and others, 1977).

Comments — We have 37 collections and 157 specimens of this species. However, in BISO we only collected 7 females from a single location, and females cannot be determined to species.

Suborder Arctoperlaria Zwick Group Systellognatha Enderlein

Family Chloroperlidae Okamoto sallflies

There are more than 150 known species in 19 genera of sallflies, primarily found in the Holarctic regions (Fochetti and Tierno de Figueroa, 2008). Ten genera and nearly 80 species are found in North America (Stewart and Stark, 1988). We found 13 species in 5 genera in the parks.

Genus *Sweltsa* Ricker — [Habitat — Lotic erosional: Habit — Clingers: Trophic — Predators (engulfers; Chironomidae, Simuliidae)] *Sweltsa* contains about 40 species distributed in the Oriental, Palearctic, and Nearctic Realms, with 30 species known from North America. Nine species are found in the East, and we collected four in the parks. These insects are highly sensitive to disturbance, and are assigned a genus-level tolerance value of 0.0.

Comments — We collected a single female from Hunting Creek in GUCO.

Family Perlidae Latreille stones

This is the largest family of stoneflies, having approximately 50 genera and more than 1,000 species worldwide. This is the only family of Plecoptera that occurs in the Nearctic, Neotropical, Palearctic, Oriental, and Ethiopian Realms. In eastern North America, 15 genera and nearly 80 species are known. The larvae are primarily predators, feeding on a wide variety of invertebrates. One western US species has been documented feeding on trout eggs (Claire & Phillips 1968). Most species appear to be univoltine, but some are known to have bivoltine populations, and trivoltine life cycles have been suggested for others (Peckarsky 1979). Larvae live in heterogeneous rocky substrates. Certain species are known to prefer a particular range of particle sizes over others (Peckarsky 1979). Larvae of Perlidae are carnivorous and feed on a wide range of prey species, but seem to prefer baetid mayflies to other prey.

Subfamily Acroneuriinae Klapálek

Genus *Perlesta* Banks — [Habitat — Lotic erosional and depositional (in detritus): Habit — Clingers: Trophic — Predators (engulfers; Chironomidae, Simuliidae, Ephemeroptera, Trichoptera), facultative collectors gatherers (especially in early instars)] This genus might be an eastern Nearctic endemic, but two species from China are currently placed in this genus (Stark 2004). Seventeen species are presently known from North America, but several undescribed species are known from the study area and from several of the parks. Many species of *Perlesta* are assigned a tolerance value of 0.0.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Perlesta decipiens</i> (Walsh, 1862) Widespread Stone	BISO, CUGA, GRSM ^(L) , GUCO	AR, CO, IA, IL, IN, KY, MO, NC, ND, NE, NM, OH, OK, PA, SD, TN, TX, VA, WI, WV, WY	245-389 m	G5	0.0	8 Jun - 28 Jul

Comments — DeWalt and others, (2001) found this species in all but the smallest streams in Illinois. Female forewing up to 13 mm in length, male forewing up to 10 mm. We found 12 females from Hunting Creek.

ORDER MEGALOPTERA LATREILLE

ALDERFLIES, FISHFLIES, DOBSONFLIES AND HELLGRAMMITES

Cover & Resh (2008) provide a recent review of the global distribution of the order. Megaloptera is a small, holometabolous order of 328 species in two families distributed worldwide. The Corydalidae are known as dobsonflies, hellgrammites, and fishflies. Two hundred forty-seven species are divided into two subfamilies, Corydalinae and Chauliodinae. Some authorities treat these subfamilies as families. The family Sialidae is known as the alderflies and has 81 species. All Megaloptera larvae are aquatic, although some are adapted to temporary waters and may pass months-long dry periods in burrows. Larval habitats are diverse, and are discussed more thoroughly below. Larvae of all species are carnivorous, feeding on virtually any suitable, smaller invertebrates, including each other. Larvae pass through 8-15 instars. The larval stage of many species lasts one or two years, but some species in cold or temporary streams may take five years to develop. As with all holometabolous insects, megalopterans pass through a pupal stage before becoming an adult. In order to pupate, the larvae crawl out of the water, find a suitable protected site in leaf litter, soil, or decomposing logs, and construct a chamber in which they pupate. Larvae in temporary streams may pupate under rocks in the stream after it dries out. Adults live for about one week, during which time they do not feed but may take some liquids, such as nectar. Oviposition usually occurs over the water on rocks, logs, branches, or other substrates such as bridges. Larvae must find their way into the water after hatching.

We did not find any megalopterans in GUCO.

ORDER TRICHOPTERA KIRBY

CADDISFLIES

Trichoptera is the largest of the predominately aquatic insect orders, with approximately 15,000 described species in 600 genera and 47 families (Holzenthal and others, 2007). The majority of Trichoptera have aquatic larvae, with only a small number having semi-terrestrial or terrestrial larvae. Caddisflies are found in virtually every freshwater habitat throughout the world, except Antarctica. A small number of species is found in brackish and marine habitats. Most larval caddisflies make cases or fixed retreats, which play roles in larval feeding, respiration, and camouflage. Those species that do not make cases or fixed retreats are free-living. In the family Hydroptilidae, or microcaddisflies, the first four larval instars are free-living, but the final fifth instar larvae make a case. Trichoptera are most closely related to the order Lepidoptera, the moths, skippers, and butterflies. Adult caddisflies, in fact, closely resemble moths. Adult caddisflies range in length from about 1.5 to 43 millimeters. Like Lepidoptera, Trichoptera undergo complete metamorphosis, progressing from egg to larva to pupa to adult. Most caddisflies have a 1-year or univoltine life cycle, although bi- and multivoltine life cycles are known. The majority of species are nocturnal as adults; only a relatively few species are day-active.

The use of silk for case making, net spinning, and other functions is one of the defining characteristics of Trichoptera, and is one of the significant factors responsible for the ecological success of the order. Wiggins and Mackay (1978) list five general categories of uses that allow caddisfly larvae to exploit their aquatic habitats: (1) constructing fixed retreats with feeding nets, (2) making fixed tubular retreats from which the larvae extend to feed on surrounding substrates or passing prey items, (3) building portable cases for protection while moving about and grazing on the substrate in exposed situations, (4) fashioning tubular cases or retreats to maintain or enhance current flow over the body, (5) providing a safety line that provides security for free-living larvae searching for prey in strong currents. In addition, the use of silk has also been considered to increase the stability of gravel substrates in streams, and thus has the potential to reduce the effects of flooding in areas with high densities of filter-feeding caddisflies (Cardinale and others, 2006; Statzner and others, 1999).

Family Rhyacophilidae Stephens

free-living caddisflies

The Rhyacophilidae consists of more than 700 species in five genera, one of which, *Rhyacophila* Pictet, contains nearly 600 species. Two genera occur in North America, but only the genus *Rhyacophila* occurs in the study area. Rhyacophilid larvae are free-living, without a case or a retreat. The larvae are predators that search their cold stream habitats for prey items, typically other caddisfly larvae, stonefly and mayfly nymphs, as well as many other organisms of the appropriate size. When larvae are ready to pupate, they construct a domelike rock shelter in a protected area on stable substrate in the water.

Genus *Rhyacophila* Pictet – [Habitat – Lotic erosional: Habit – Clingers (free ranging): Trophic – Predators (engulfers), a few scrapers, collectors gatherers, shredders herbivores (chewers)] More than 120 species are known from North America and we recorded 26 species in the parks. *Rhyacophila* larvae are restricted to well-oxygenated, cold water streams. Most species apparently are univoltine. When a larva is ready to pupate, it finds a protected spot under or between rocks, or even within rotten wood, and builds a loose shelter of sand and gravel held together with silk. Pupation normally lasts several weeks (Manuel & Folsom 1982), but we have found one species during this study that survives in an intermittent stream by remaining in its pupal cocoon for up to four months. Most *Rhyacophila* larvae in the parks can be identified with available literature (Flint 1962; Weaver & Sykora 1979; Unzicker and others, 1982; Prather & Morse 2001, as corrected by Stocks & Morse 2004), but considerable uncertainty remains concerning some species, as noted below. Much of the information in the Comments below are from Flint (1962).

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Rhyacophila acutiloba</i> JC Morse & HH Ross, 1971	BLRI, GRSM ⁽¹⁾ , GUCO , MACA	KY, MA, ME, NC, NH, NY, SC, TN, VA, VT, WV	221-1656 m	G5	1.0	5 Jun (Apr - Jun)

Comments - A new record for Kentucky (Floyd et al. 2012). Larvae inhabit streams 2-9 m in width. Larva up to 20 mm in length, adult up to 10 mm. We have 27 collections and 70 specimens of this species, including 4 larvae from GUCO.

Family Hydropsychidae Curtis retreat-making caddisflies

Hydropsychidae is the third largest family of caddisflies, with over 1,500 described species (Holzenthal and others, 2007) in five subfamilies, four of which occur in the study area. The taxonomy of the family is in a state of flux. Some authors have treated one of the subfamilies as a separate family (Arctopsychidae: Nimmo, Schmid 1998). Other authors split the large genus *Hydropsyche* into two or more genera. Recent studies using molecular and/or morphological analyses find little support for splitting the Arctopsychinae from the larger family or for splitting out the genera *Ceratopsyche* or *Symphitopsyche* from *Hydropsyche*. We have adopted the more conservative approach here. The nets and retreats made by the larvae have attracted a good deal of ecological and evolutionary study (Alstad 1982, 1986; Edler & Georgian 2004; Georgian & Wallace 1981; Loudon 1990; Thorp 1983; Thorp and others, 1986; Wallace & Malas 1976; Wallace and others, 1977). Each subfamily, genus, and species tends to have characteristic retreat and net structure, and a consistent net mesh size, which have led to considerable investigation into the mechanisms by which the larvae partition the stream resources of space, current speed, and drifting particulate matter. All larvae of Hydropsychidae have a scraper and file feature that permits them to make sounds. This has been demonstrated in *Cheumatopsyche* and *Macrostemum*, but has been best studied *Hydropsyche* and is discussed under that genus.

Subfamily Diplelectroninae Ulmer

Genus *Diplectronea* Westwood — [Habitat – Lotic erosional (headwater streams): Habit – Clingers (net spinners, fixed retreats): Trophic – Collectors filterers (coarse particles, especially detritus)] This genus has about 100 species worldwide, but is absent from Africa and most of South America (Flint and others, 2004). Atypically among hydropsychids in North America, adult genitalia are of little use in distinguishing species, so characters of the head of adults are given more weight. Larvae seem to hold more promise for species discrimination, so an approach that relies on larval characters and molecular analyses is being used to clarify what is likely a complex of several species instead of the two listed here. Because the adults are so unreliably identified, we list below records based on larval collections. Consequently, we do not present flight dates from our data, but instead only provide flight dates based on published information.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Diplectronea modesta</i> N Banks, 1908	BISO, BLRI, CHCH, COWP, CUGA, FODO, GRSM, GUCO , KIMO, LIRI, MACA, OBRI, SHIL	AL, AR, CT, DE, FL, GA, IL, IN, KS, KY, LA, MA, ME, MI, MO, MS, NC, NE, NH, NS, NY, OH, OK, ON, PA, QC, SC, SD, TN, VA, VT, WI, WV	112-1533 m	G5	2.2	(Mar - Sep)

Comments — This "species" is a complex of at least five forms. These forms are distinct on the basis of molecular analyses, and can be recognized as larvae, but not yet as adults. Several of these forms have been collected during this survey. Ongoing studies combining molecular and morphological methods are attempting to clarify this situation and determine which, if any, of the recognizable forms should be treated as separate species or other taxonomic categories. We labeled the adults as "*Diplectronea* species." We suggest that this species be considered of special interest because of the current taxonomic uncertainty. Studies of the biology of *D. modesta* in the literature indicate a univoltine life history (i.e., Benke & Wallace 1980), but all such information will need to be reevaluated when the current systematic studies are completed. We have 382 collections and 4,930 specimens of this species complex, including 5 immatures from GUCO.

Family Polycentropodidae Ulmer

polycentropodid caddisflies

This cosmopolitan family has more than 650 described species in 15 ((Chamorro and Holzenthal, 2011; Holzenthal and others, 2007)) or 23 ((de Moor and Ivanov, 2008)) genera. The Oriental region has approximately 230 described species, the Neotropical realm has more than 170, the Palearctic has more than 100, while the Nearctic, Afrotropical, and Australian regions have less than 100 species each. In North America fewer than 80 species are known among 8 genera. We collected 30 species in 6 genera during this study. Larvae do not make cases; rather they make silken nets of several characteristic configurations. These are described for each genus. Many are filter feeders, however others are predators.

Genus *Nyctiophylax* Brauer - [Habitat - Lotic erosional and depositional, lentic littoral: Habit - Clingers (silk tube retreats): Trophic - Predators (engulfers), collectors filterers, shredders herbivores] More than 100 species have been described in this genus, from most regions of the world. The majority of species are found in the Oriental, with about 12 species known from North America. We collected 9 species during this survey, of which 3 were found in BISO. Larvae are predators that make retreats in substrate depressions that are very similar to those made by *Cernotina*. Life history is generally unknown for *Nyctiophylax* species, but probably is univoltine for most (Unzicker and others, 1982). A genus level tolerance value of 0.9 has been assigned.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Nyctiophylax denningi</i> JC Morse, 1972	BLRI, GRSM, GUCO , KIMO, LIRI, NISI, SHIL	AL, DE, GA, MS, NC, PA, SC, TN	124-1039 m	G4	0.9	18 May - 12 July (May - September)

Comments - We have 40 collections and 543 specimens of this species. We collected a single male from Hunting Creek in GUCO.

Suborder Integripalpia Martynov

This is the suborder of the case-building caddisflies, which represents just over one third of all Trichoptera. The development of cases was a major milestone in the evolution of caddisflies (Mackay & Wiggins 1979), and, of course, cases have attracted a great deal of attention from scientists, and people in general. The roles of cases continue to be debated, with many ideas being propounded about their function in caddisfly biology. An obvious idea is that cases provide protection for the larvae, either directly by providing a shelter when a larva encounters a predator, or indirectly by serving as camouflage or by protecting the larva from environmental hazards. Some workers suggest that cases are essential in respiration, enhancing the flow of fresh water over the gills of the larva as it undulates its abdomen within the case. This has allowed many species to colonize and inhabit warmer, lower oxygen habitats than might otherwise have been possible. In addition, it is possible that cases serve as a means of reducing cannibalism among larvae under certain conditions (Wissinger and others, 2004). Good expositions of many of these ideas are found in Wiggins (1996, 2004). Most of these ideas have supporters and critics, and no doubt many new ideas remain to be postulated. Under any circumstances, cases are a key element in the lives of the Integripalpia.

Family Thremmatidae Martynov

horsehead caddisflies

This family has a disjunct North America – eastern Asia distribution. Some subfamilies and genera have closest relatives in the two regions to the exclusion of other regions. Worldwide there are fewer than 90 species in seven genera. Only one genus occurs in the study area, *Neophylax* which has about 40 species worldwide. There are 21 species in North America, with 17 in the East.

Genus *Neophylax* McLachlan – [Habitat – Lotic erosional: Habit – Clingers (case tapered, slightly curved, mineral with ballast stones one each side): Trophic – Scrapers] Currently about 32 species of *Neophylax* are known from North America, Western Palearctic, and Oriental regions. In the seven states of the study area 16 species are known, along with at least two undescribed species. Eleven species were found during this inventory, although only larvae were found for *N. fuscus*. Larvae make a very distinctive case that is instantly recognizable in the field. Cases are robust and tubular, slightly curved and tapered, and made of rock pieces, and often have larger “ballast” stones laterally. Pupal cases are firmly attached to the underside of stable rocks. Larvae are found in springs, creeks, and large rivers. Within a stream species tend to be longitudinally distributed, with overlapping populations resulting in more than one species being found at a single site. Larvae are scrapers, feeding on diatoms, periphyton, and organic debris from the surfaces of rocks. *Neophylax* are univoltine, the adults normally emerging in the fall following a summer diapause of two to six months in the prepupal stage. Eggs are laid under rocks or overhanging banks above the water surface (Beam & Wiggins 1987), although at least one western Nearctic species lays eggs in water. Larval growth rates vary considerably. In North Carolina, Georgian and Wallace (1983) demonstrated that *N. consimilis* takes ≤ 135 days to progress from 1st instar to prepupa, while in Ontario, Beam and Wiggins (1987) demonstrated that *N. aniqua* takes up to 240 days. When larvae prepare for diapause they tend to aggregate and are found in clumps of 5 – 20 cases on the same rock. Often the current generation of larvae uses the same locations for aestivation as previous generations, as empty pupal cases of the prior generation persist and can be found together with the current cohort. This has been demonstrated to lead to increased aquatic invertebrate diversity compared with rocks that do not have aggregations of *Neophylax* larvae (McCabe & Gotelli 2003). Vineyard and others (2005) recently revised *Neophylax*. This revision is the best source for information and keys to the species. Although *Neophylax* larvae are usually easily identifiable, in biomonitoring programs they are given a genus level tolerance value of 1.6.

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Neophylax atlanta</i> HH Ross, 1947	COWP, GUCO	AL, GA, NC, SC, VA	254-280 m	G3	1.6	21 Oct (Oct - Nov)
Comments — This is considered one of the rarest <i>Neophylax</i> in eastern North America (Vineyard et al. 2005). Our record of 2 larvae from an unnamed stream in GUCO is the first for North Carolina.						
<i>Neophylax oligius</i> HH Ross, 1938	BLRI, CUGA ^(L) , GRSM ^(L) , GUCO , KIMO	AL, CT, DE, GA, MA, MD, ME, MI, MN, NC, NE, NH, NY, OH, ON, PA, QC, SC, TN, VA, VT, WI	197-1265 m	G5	1.6	11-31 Oct (Aug - Nov)
Comments - Ellis (1962) found that <i>N. oligius</i> emerged a few weeks earlier than most other <i>Neophylax</i> in a stream in Michigan. Adult up to 12 mm in length. We have 20 collections and 122 specimens of this species.						

Guilford Courthouse National Military Park

Survey of Aquatic Insects of the Cumberland Piedmont and Appalachian Highlands Monitoring Networks

Species	Parks	States	Elevation Range	Rankings	Tolerance Value	Flight Dates
<i>Neophylax ornatus</i> N Banks, 1920	BLRI, COWP, GRSM ^(L) , GUCO , NISI	AL, GA, NC, NF, NH, NS, ON, PA, QC, SC, TN, VA, VT, WV	135-1694 m	G4, ALS1	1.6	6 Jun - 19 Aug (Jul - Oct)
Comments - The distinctively marked <i>N. ornatus</i> emerges earlier than most other species of <i>Neophylax</i> . It is restricted to springs and first-order streams (Vineyard et al. 2005). It is considered critically imperiled in Alabama. Adult up to 13 mm in length. We have 60 collections and 189 specimens of this species.						

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